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ABSTRACT

The goal of this monograph is to explain the evaluation program designed by Schaumburg Community Consolidated District 54, Schaumberg, Illinois. It discusses the process used in the development of the model, the product, the implication for classroom teachers and the effects of using an evaluation to assess science process skills. The process skills used are defined and related to sample questions in the Schaumburg testing model. Appendices include sample questions from paper-and-pencil fourth and sixth grade content/process instruments, sample questions from paper-and-pencil attitude tests used in fourth, fifth, and sixth grades, and a sample fifth grade hands-on evaluation test. The stages of the change process in the school system is highlighted. The paper concludes that student attainment of process skills tends to be nebulous and unrelated to academics. (CW)

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MONOGRAPH

Science Process Evaluation Model

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SE 048 982

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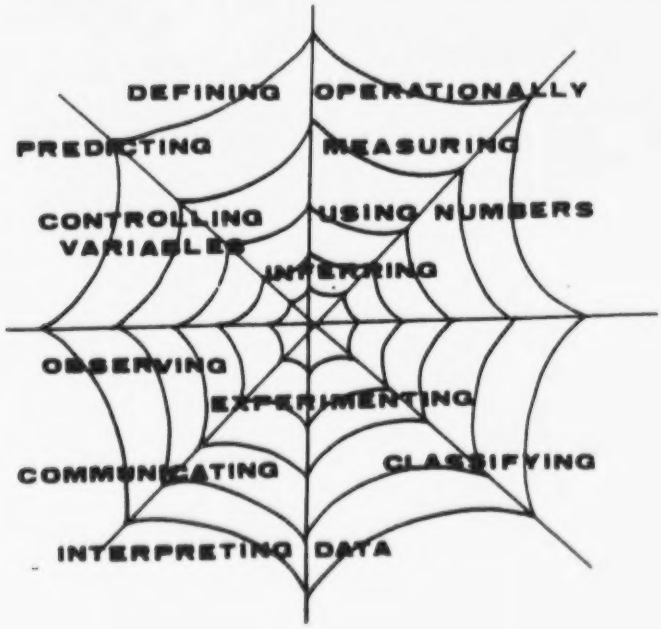
The goal of this monograph is to explain the evaluation program designed by Schaumburg Community Consolidated District 54, Schaumburg, Illinois. The following points will be discussed: the process used in the development of the model, the product, the implications for classroom teachers, and the effects of using an evaluation to assess science process skills. Process skills are defined as follows and are related to sample questions in the Schaumburg testing model.

WEB OF INQUIRY PROCESSES



1. Observing. Students begin with identifying objects and object properties and proceed to the identification of changes in various physical systems, the making of controlled observations, and the ordering of a series of observations.

2. Communicating. Students begin with simple transmission of information to others and progress to describing a variety of physical objects and systems and the changes in them and to the construction of graphs, tables, diagrams, and reports for observed results of experiments.

3. Classifying. Students begin with simple classifications of various physical and biological systems and progress through multi-stage classifications, their coding, and their tabulation.

4. Using Numbers. Students begin with identifying sets and their members and progress through ordering, counting, adding, multiplying, dividing, finding averages, and using decimals and powers of ten.

5. Measuring. Students begin with identification and ordering of lengths and proceed with the demonstration of rules for measurement of length, area, volume, weight, temperature, force, speed, and a number of derived measures applicable to specific physical and biological systems.

6. Inferring. Students begin by drawing relationships among the things they observe and generalize upon experiences. They continue into the complex tasks of interpreting tabular and graphical data.

7. Predicting. Students begin with simple guesstimates and progress to interpolation and extrapolation in graphically presented data and to the formulation of methods of testing predictions.

8. Controlling Variables. Students will begin by identifying the factors which will or will not affect the outcome of an experiment. They proceed to the identification of those factors that are held constant and those factors that are manipulated. Development proceeds to the level at which students, being given a problem, inference, or hypothesis, actually conduct an experiment, identify the variables, and describe how variables are controlled.

9. Defining Operationally Students begin with the distinction between definitions which are operational and those which are not and proceed to the point where they construct operational definitions in problems that are new to them.

10. Interpreting Data. Students begin with simple descriptions based on previous experiences and progress to descriptions based on previous experiences and progress to descriptions of graphic data and inferences based upon them. They continue to the constructing of equations to represent data, relating data to statements of hypothesis, and making generalizations supported by experimental findings.

11. Experimenting. Students begin by manipulating materials. This skill may involve the trial and error manipulation of discovery activities and progress to an organized testing of hypothesis.

In Improving Indicators of the Quality of Science and Mathematics Education in Grades K-12 (1988), a report to the National Science Foundation, a statement was made that there should be research to develop indicators to provide "more penetrating insights" into the quality of K-12 science instruction. The report notes that using only testing for student achievement is not a sufficient tool for evaluating an instructional program. Data should be gathered to assess attitudes and behavior before a picture of science literacy can be derived.

A major effort to audit all curriculum areas in District 54 was initiated in 1984. The science assessment task was presented to the district's Science/Health Committee, comprised of one teacher representative from each of the twenty K-6 schools and four junior high schools. A theoretical assessment construct was developed after a review of the related literature and teacher participation in testing and evaluation courses developed by Dr. John Staver of the University of Illinois, Chicago. The model included the assessment of content, process, and attitude.

The actual development of these instruments relied upon teacher assistance. Week long summer writing projects were initiated to delineate major grade level objectives and generate appropriate test questions. During a one year trial, tests were administered. Grade level committees met through released time to analyze the testing data and to make revisions.

The result of the above activities were three separate testing components. The first component assessed students' knowledge of content and certain areas of process (see Appendix A). The second component assessed students' attitudes through paper and pencil surveys (see Appendix B). The third test was designed using materials and hands-on activities to assess the level at which process skills were attained (see Appendix C). These process skills were emphasized in the science curriculum. All tests were administered to a sample of randomly selected students at grades 4 to 6.

The analysis of the data derived form the trial test continues to impact and change the curriculum. The change process is accomplished in the stages highlighted below. It appears to be linear in nature, however, there are overlaps.

1. The test results are shared with principals and teachers.
2. Science/Health Committee members receive a synopsis of trends. This enables members to make recommendations relative to curriculum modifications.
3. Based on the recommendations, curriculum revisions are made.
4. After revisions are made, units are piloted.
5. When refinements are in place, targeted teachers participate in inservice, based on areas of need.

No area of the science curriculum needs more attention than process skills. Teachers in elementary schools have a propensity for teaching content. Content attainment is easily evaluated and teachers can derive immediate satisfaction in "seeing" children learn content. It is an easy task to assign letter grades relative to a student's ability to learn content.

Student attainment of process skills, on the other hand, tends to be nebulous and unrelated to the world of academics. Through the district evaluation of process skills positive results can be obtained.

1. The importance of process skills will increase for teachers and building administrators who value test scores.
2. More process activities will be implemented in the classroom.
3. The move away from lecture/content will improve testing and evaluation instruments.
4. Data can be gathered about the effectiveness of process activities.
5. Curriculum change can be based on emperical data.

The system of science evaluation in Schaumburg School District 54 continues to be refined. The district's desire to evaluate process is genuine and will continue to improve and grow. Hopefully, it will become one of the prime tools for assisting teachers and administrators in making decisions regarding effective curriculum change and teacher training.

APPENDIX A

SAMPLE QUESTIONS FROM PENCIL AND PAPER 4TH AND 6TH GRADE CONTENT/PROCESS INSTRUMENTS

1. Which factors will effect how long a brine shrimp will live.

   A. Amount of salt in the water.
   B. Temperature of the water.
   C. Pollution in the water.
   D. All of the above.

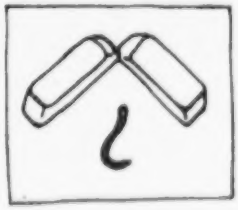
2. Why is it important to put a cover on your brine shrimp solution?

   A. Brine shrimp may jump out.
   B. The salt may evaporate.
   C. The water may evaporate.
   D. Brine shrimp eggs may shrink.

3. In which two stages do mealworms use bran for shelter without eating it?

   A. Egg, lava
   B. Egg, pupa
   C. Egg, adult
   D. Lava, pupa

4. Pat put her mealworm in a small box with two erasers, as is pictured in the drawing below. What do you think happened when the mealworm reached the corner where the erasers meet?



   A. He stopped and stayed there.
   B. He turned around.
   C. He backed up.
   D. He pushed through the erasers.

5. One drop of water, alcohol, detergent and corn syrup each have been dropped on a piece of glass from a height of 4 inches. Which one of these drops is alcohol?

A. B. C. D.

6. Each of these cups is filled with one of the four "K. P." liquids. To which cup can you add the most drops without having the liquid spill over?

alcohol A. water B. corn syrup C. detergent D.

7. Which drop shows the best surface tension? These pictures are looking down on the drops.

A. B. C. D.

8. Which of the following would you use to examine very small things like grains of sand?

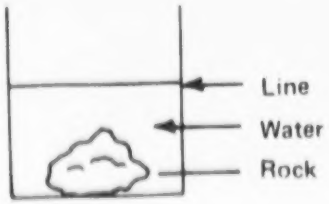
A.

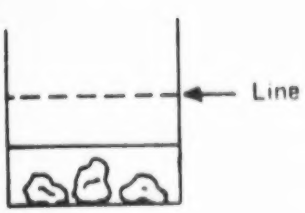
B.

C.

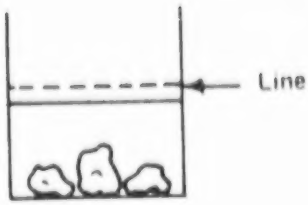
D.

9. When a rock is put into a pail of water, the water comes up to the line as the picture shows. If the rock is broken into three pieces, which of the following pictures shows how high the water is?

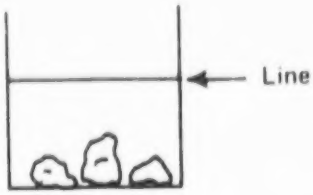




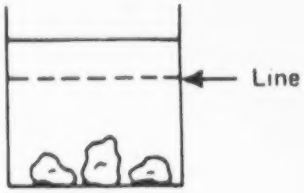
A.



B.



C.



D.

10. Which water drop should make things look biggest?

A B C D

11. Which picture looks most like an onion cell?

A.

B.

C.

D.

12. Tom wanted to find out whether plants can grow better in the dark or in the light. He put a pot with 6 radish seeds in a dark room and pot with 6 bean seeds on the window sill.

radish seeds

bean seeds

He added the same amount of water to both pots. The bean seeds grew better than the radish seeds, so Tom said his plants grew in the light.

One of the things Tom should have done to be able to say this and be correct is:

A. Watered both pots more.
B. Watered the radish seeds more.
C. Put the same kind of seed in both pots.
D. Grown the seeds in water instead of soil.

APPENDIX B

SAMPLE QUESTIONS FROM PENCIL AND PAPER ATTITUDE TEST USED IN 4TH, 5TH, AND 6TH GRADE.

SCIENCE PREFERENCE

Please answer each of the following items as honestly as possible. Bubble in your answer on the answer sheet.

1. Do you wish you had more time for science in school?

   A. yes B. no C. I don't know

2. Is your science class fun?

   A. yes B. no C. I don't know

3. Is your science class interesting?

   A. yes B. no C. I don't know

4. Is your science class exciting?

   A. yes B. no C. I don't know

5. Is your science class boring?

   A. yes B. no C. I don't know

6. Does your science class make you feel uncomfortable?

   A. yes B. no C. I don't know

7. Does your science class make you feel successful?

   A. yes B. no C. I don't know

8. Does your science class make you feel curious?

   A. yes B. no C. I don't know

9. Does your teacher ask you questions about science?

   A. yes B. no C. I don't know

10. Does your teacher like for you to ask questions about science?

    A. yes B. no C. I don't know

11. Does your teacher like science?

    A. yes B. no C. I don't know

12. Does your teacher know a lot about science

A. yes B. no C. I don't know

13. Does your teacher admit to not knowing answers to your science questions?

A. yes B. no C. I don't know

14. Are the things you learn in science useful to you when you are not in school?

A. yes B. no C. I don't know

15. Do you think that knowing a lot about science will help you in the future?

A. yes B. no C. I don't know

16. Do you feel that the science you study is generally useful to you?

A. yes B. no C. I don't know

17. Do you think that being a scientist would be fun?

A. yes B. no C. I don't know

18. Do you think that being a scientist would make you rich?

A. yes B. no C. I don't know

19. Do you think that being a scientist would be a lot of work?

A. yes B. no C. I don't know

20. Do you think that being a scientist would be boring for you?

A. yes B. no C. I don't know

21. Do you think that being a scientist would make you feel important?

A. yes B. no C. I don't know

22. Do you think that being a scientist would make you lonely?

A. yes B. no C. I don't know

APPENDIX C

SAMPLE FIFTH GRADE HANDS-ON EVALUATION TEST

Administrators Instructions

OBJECTIVE	ESTIMATED TIME	ANSWER	NEED	PROCESS
Classification	15 min		For each student 3 rock samples, 1 nail, vinegar streak plate. All in bags labeled Bag 1.	In bag 1, you have 3 rock samples. Using the provided test materials and your brain, complete the Rock Chart.

Student Page

You have 3 rock samples. Using the provided test materials and your brain, complete the following rock chart.

ROCK CHART

IDENTIFICATION COLOR	ROCK COLOR	LUSTER	TEXTURE	WEIGHT	HARDNESS	STREAK	VINEGAR
RED							
BLUE							
GREEN							

Administrators Instructions

OBJECTIVE	ESTIMATED TIME	ANSWER	NEED	PROCESS
	7 min	A (3-5) C (1-6)	1 per student, 3 wire ends striped bulb and bulb holder, battery and battery holder. (Instruct students to take tester apart when finished.) Have extra supplies	Open the box labeled Question 7. Using the provided materials, test to see which of the points are connected on your mystery box. Try them all before answering. Possible answers: A. 1-4 B. 3-5 C. 1-6 D. 2-4

Student Page

Which of the points are connected on your mystery box? Try them all before answering yes or no.

A. 1-4 Answer _____
B. 3-5 Answer _____
C. 1-6 Answer _____
D. 2-3 Answer _____

Administrators Instructions

OBJECTIVE	ESTIMATED TIME	ANSWER	NEED	PROCESS
Performing Investigations	7 min		For each student have 1 each dropper bottle with screw cap. 3" x 3" wax paper napkins 2" x 3" graph paper	Distribute the graph paper and Bag 3. In this question, I want you to perform an experiment. Place the lined paper on your desk, put the wax paper on top of the lined paper. Use the dropper to make a water drop pile with one drop. Use the dropper to make a drop pile with four dropper drops. Which magnifies the lines most?

Student Page

Which drop magnifies the lines most? Answer _____

Administrators Instructions

OBJECTIVE	ESTIMATED TIME	ANSWER	NEED	PROCESS
Performing Investigations	7 min		1 magnifier with 3 different magnifications and set up in above question.	Design an experiment that will help you complete the following graph. Use the 3 lenses on the magnifier. (Measure as accurately as possible.)

Student Page

Design an experiment that will help you complete the following graph. Use the 3 lenses on the magnifier. (Measure as accurately as possible.)